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Non-Governmental Public Norm Enforcement in Large Societies as a Two-Stage Game of Voluntary Public Good Provision‡

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Abstract

In small groups, norm enforcement is achieved through mutual punishment and reward. In large societies, norms are enforced by specialists such as government officials. However, not every public cause is overseen by states, for instance those organized at the international level. This paper shows how non-governmental norm enforcement can emerge as a decentralized equilibrium. As a first stage, individuals voluntarily contribute to a non-governmental agency that produces an incentive system. The second stage is the provision of a public good on the basis of private contributions. The incentive system increases contributions by means of public approval or disapproval of behavior. It is shown that, even in large populations, non-governmental norm enforcement can be supported in a non-cooperative equilibrium of utility-maximizing individuals. This result is in sharp contrast to those obtained in the standard situation of voluntary provision of an intrinsic public good which – without altruism or related motives – is eroded by free-riding. Reliance on altruistic behavior is not required in supplying the second-order public good 'norm enforcement' in large societies.

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‡ A first version of the basic idea of this paper was presented in a working paper by *Falkinger* [2004]. This new version of the paper exploits the Aggregative Game Approach as developed by *Cornes and Hartley* [2003, 2007] in order to analyze this idea in a more general and comprehensive way. For this purpose Josef Falkinger asked Wolfgang Buchholz and Dirk Rübbelke to join him as authors. Some of the research by Dirk Rübbelke on this paper was conducted during his stay at the Australian National University in Canberra in 2011.
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1. Introduction

In small groups, mutual punishing and rewarding promotes the compliance of the members of the group with norms and helps to improve the allocation of public goods (see, e.g. *Fehr and Gächter* [2000, 2002] and *Fehr and Fischbacher* [2003]). In larger groups where personal interaction is weak and the behavior of others cannot be effectively monitored (*Carpenter* [2007]) the enforcement of norms and public good contributions requires other means: Either formal institutions (as the state) which employ professional staff (as police or tax investigators) to enforce public good contributions or, alternatively, non-governmental organizations (NGOs) with normative powers.[1] For instance, environmental NGOs like Greenpeace run campaigns against use and consumption of certain goods. By approving and disapproving environmentally harmful behavior and exerting social pressure these organizations strive for fostering behavior which in the end should lead to an improvement of environmental quality and thus to the provision of a public good. As there is no central government at the world-wide scale, international NGOs play a particularly important role in the provision of global public goods (as climate protection).[2] This raises the question why non-governmental public norm enforcement is voluntarily supplied in large societies. The analysis presented in this paper provides a game-theoretic explanation.

Although they are not able to exert coercion, non-governmental agencies have in common with governments that resources have to be invested in manpower and technical equipment to establish an effective norm-enforcement mechanism for inducing contributions to the (global) public good. The resources for such a mechanism, however, have themselves typical features of a public good, i.e. non-excludability and at least partial non-rivalry.[3] As NGOs are private institutions their resources have to be financed by voluntary contributions. Therefore, we are confronted with two intertwined problems of private public good provision which in the following will be treated in a two-stage game: At the first stage agents decide how much they will voluntarily pay for funding a norm-enforcement agency which produces sanctions and rewards. At the second stage they then – again non-cooperatively but influenced by the enforcement mechanism as established at stage 1 –

[1] The high importance of formal and informal sanctions for the stabilization of a large organization was already a main topic in the classical work by *Olson* [1965].
[2] On their normative powers see for instance *Boli and Thomas* [1997], *Finnemore and Sikkink* [1998], *Brown and Moore* [2001] and *O´Neill, Balsiger and van Deveer* [2004].
[3] In *Yamagishi*'s [1986] words we have a problem of "instrumental cooperation". His design for testing instrumental cooperation corresponds to our stage 1.

decide how much they will contribute to a public good like, e.g., climate protection. The enforcement agency increases the incentives to contribute to the ´intrinsic´ public good at stage 2 and thus helps to cure the underprovision problem which otherwise pertains to voluntary public good provision (see, e.g. *Cornes and Sandler* [1996, pp. 143–159]). The larger the enforcement funds provided at stage 1, the stronger are the rewards and punishments at stage 2.[4]

Our analysis will proceed as follows: In Section 2, we describe our basic model and analyze the stage-2 equilibrium. The analysis is essentially based on the Aggregative Game Approach as developed by *Cornes and Hartley* [2003, 2007]. In the subsequent sections we distinguish two scenarios concerning the partitioning of the whole society in the sanctioning group on the one hand and the group which is exposed to the sanctions on the other. Section 3 deals with the case where both groups are completely disjoint. In contrast, in Section 4, the sanction mechanism is targeted towards the whole population while the group which finances the enforcement mechanism may be smaller, so that both groups overlap and even may coincide. In both cases we determine subgame-perfect equilibria under quite general conditions but use special utility functions and punishment-reward schemes to explore comparative statics effects. A major result of our analysis will be that also privately financed enforcement agencies are well able to raise substantial funds from rational and self-interested individuals and to increase voluntary contributions to the intrinsic public good even if the size of the population is large. Section 5 concludes and addresses some normative issues.

2. General Framework

The economy consists of a set $N = \{1,...,n\}$ of n > 2 individuals $i = 1,...,n$ with preferences over private consumption c_i and a public good G. These preferences are represented by the identical utility function $u(c_i, G)$, which is twice partially differentiable in both arguments with partial derivatives $u_1 = \frac{\partial u}{\partial c_i} > 0$ and $u_2 = \frac{\partial u}{\partial G} > 0$, and for which the private and the public good are strictly normal. Furthermore we assume that $u(c_i, G)$ has indiffer-

[4] The analysis is related to *Okada*'s [1993, 1997] non-cooperative approach to social organizations. In his framework, however, individuals have to join an organization which collectively decides on enforcement measures within the organization. See also *Kosfeld and Riedl* [2007] and *Kosfeld, Okada and Riedl* [2009].

ence curves which, as in the Cobb-Douglas case, are tangential to the coordinate axes. Here, private consumption has a broad meaning and includes, beyond material consumption, some feeling of social esteem.[5] For the sake of simplicity the price of private consumption and the price of the public good are normalized to 1. Each agent i is endowed with a gross income y_i. The public good G is supplied in a non-cooperative contribution game by some group $B \subseteq N$ of size n_B (with $2 \leq n_B \leq n$) which has aggregate income $Y_B = \sum_{i \in B} y_i$. The public good contribution of agent $i \in B$ is denoted by g_i, and aggregate public good supply is $G = \sum_{i \in B} g_i$.

Through an increase in social esteem public approval of public good provision augments private well-being of each agent $i \in B$ by $r_i > 0$, while disapproval reduces it by $r_i < 0$. Thus agent $i\acute{}s$ budget constraint is

(1) $$c_i + g_i = y_i + r_i$$

Like in *Falkinger* [1996], the sanction level that reflects the degree of approval of agent $i \in B$ depends on the difference between her own contribution to the public good and the average contribution made by the other members of group B, such that

(2) $$r_i = \beta(g_i - \frac{1}{n_B - 1} \sum_{j \in B \setminus \{i\}} g_j).$$

In the punishment-reward scheme as described by eq. (2) the parameter β indicates the strength of (positive or negative) sanctions that agent $i \in B$ experiences when she deviates from average public good contributions as the norm. This gives a motive to care more about the public good – not because of some ‘warm glow effect’ in the sense of *Andreoni* [1990], but due to the approval and disapproval of deviations from the norm.

Norm compliance induced by internalized psychological control mechanisms would mean that the punishment-reward strength parameter β is exogenously given without requiring any economic resources. Here, however, it is supposed that β is endogenous and depends on the resources E that are expended for establishing and operating an enforcement agen-

[5] As *Becker* [1974, pp. 1066-1067] points out, an agent can improve the value of his social environment by achieving distinction, e.g. by giving to charities. Distinction is largely a private characteristic like those private merits an agent obtains from purchasing a conventional private good.

cy.[6] Hence, $\beta = \beta(E)$ which is assumed to be a twice differentiable function of E which has $\beta(0) = 0,\ \beta'(E) > 0$ and $\beta''(E) < 0$. More resources allow for a higher degree of enforcement, for instance by more frequent inspection and more effective monitoring of contribution behavior ($\beta'(E) > 0$), while the marginal productivity of enforcement expenditures is decreasing ($\beta''(E) < 0$).[7] Under non-governmental norm enforcement, E is also a public good whose supply is determined in another non-cooperative game through contributions made by a group $A \subseteq N$. If e_i denotes the contribution of agent $i \in A$ to the enforcement fund the total size of this fund is $E_A = \sum_{i \in A} e_i$.

The groups A and B may be disjoint or overlap and then even comprise the whole economy, i.e. $A = B = N$. In any case, we have the following two-stage game: At stage 1, the agents from group A non-cooperatively contribute to the enforcement fund E run by a non-governmental agency. At stage 2, the agents from group B non-cooperatively contribute to the public good G under the punishment reward scheme described by eq. (2). We intend to characterize subgame-perfect equilibria of this two-stage game. As a first step we apply the Aggregative Game Approach developed by *Cornes and Hartley* [2003, 2007] to analyze the equilibria which, for a given size E_A of the enforcement fund, result at stage 2 of the game. In the case of voluntary public good provision the Aggregative Game Approach determines Nash equilibria by first identifying potential equilibrium positions of agents on their expansion paths in the (c, G)-space and then applying the aggregate budget constraint.

The punishment-reward scheme given by eq. (2) changes the effective price of the public good for each agent in group B to $1 - \beta(E_A)$ so that the marginal rate of transformation between the private good and the public good G becomes $\mu(E_A) = \dfrac{1}{1 - \beta(E_A)}$. The assumptions made for $\beta(E_A)$ imply that $\mu'(E_A) > 0$ while μ'' could be ambiguous despite

[6] On the relationship between material incentives and social preferences see *Bowles and Polonía-Reyes* [2012]. See also *Benabou and Tirole* [2011].

[7] In the punishment-reward scheme given by (2), positive and negative deviations are treated symmetrically which is not necessarily true in reality. A more general approach would be to have $r_i = r(d(g_i, \overline{g}_{-i}^B), E_B)$ where $d(g_i, \overline{g}_{-i}^B) = g_i - \overline{g}_{-i}^B$ and $r(0, E_B) = 0$. This approach would allow to weight negative deviations more heavily and would produce results similar to those of our analysis when all agents have the same income. In particular, if $\partial r(d(g_i, \overline{g}_{-i}^B), E_B)/\partial g_i = \beta(E)$ at $g_i = \overline{g}_{-i}^B$, then the first-order conditions for optimal individual choices coincide in equilibrium with the ones in our analysis. To keep the exposition simple we will nevertheless use the specification as in eq. (2) throughout the paper.

$\beta'' < 0$. In the further analysis we assume that $\mu''(E_A) \leq 0$. When the agents in B make a strictly positive contribution to the public good G and thereby choose their optimal reactions to the public good contributions of the other agents in *B,* their marginal rate of substitution, *mrs*(c,G) = u_1/u_2, must be equalized to the effective marginal rate of transformation $\mu(E_A)$. Otherwise these agents would not be in an equilibrium position given the punishment-reward mechanism. The expansion path defines for any given marginal rate of transformation μ the optimal $c_i - G_i$-combination for agent i. Since by its nature as a public good consumption G_i is identical for all agents, the level of private consumption which is optimal at μ is fixed as soon as the level of aggregate public good provision G is determined. We denote for any given marginal rate of transformation μ, an agent´s consumption expansion path by

(3) $$c_i = h(G, \mu)$$

with partial derivatives $h_1 = \dfrac{\partial h}{\partial G} > 0$ and $h_2 = \dfrac{\partial h}{\partial \mu} < 0$ (from quasi-concavity of the utility function and normality of both goods).[8] Then, given some E_A, and thus the effective marginal rate of transformation $\mu(E_A)$, each agent $i \in B$ in a stage-2 Nash equilibrium must attain a position on the consumption expansion path.

For a characterization of the stage-2 equilibrium by means of the Aggregative Game Approach in a next step the aggregate budget constraint for group B has to be taken into account. After putting E_B into the enforcement fund group B can still use $Y_B - E_B$ for private consumption or for producing the intrinsic public good. Public good supply $\hat{G} = \hat{G}(E_A, E_B)$ in a stage-2 Nash equilibrium is then implicitly given by

(4) $$\hat{G} + n_B h(\hat{G}, \mu(E_A)) = Y_B - E_B.$$

where $\hat{c}_i(E_A, E_B) = h(\hat{G}(E_A, E_B), \mu(E_A))$ is private consumption of any agent $i \in B$ in equilibrium. In this aggregate budget constraint the individual rewards and punishments r_i do not matter since it directly follows from eq. (2) that $\sum_{i=1}^{n} r_i = 0$. Clearly, $E_B \leq E_A$. Eq. (4) provides the key for the whole subsequent analysis. To examine behavior of group A at the

[8] Instead of the term ‘consumption expansion path’ the expression ‘income expansion path’ is employed frequently in the literature, but we think that the term ‘consumption expansion path’ fits better in the context of a public good economy.

first stage of the game and thus to determine subgame-perfect equilibria we focus on two special cases: The next section considers the case that A and B are disjoint subsets of N, in Section 4 we assume $A \subseteq N$ and $B = N$.

Since the analysis of the stage-2 equilibrium by means of the equations (3) and (4) focuses on interior equilibria, some caveats and observations on the individual budget constraints are in order before turning to stage 1. Note first that $c_i < y_i + r_i$ is required for an equilibrium position on i's expansion path. If income is dispersed, this may be violated for some agents at high values of G or low values of μ, which according to (3) imply high c_i expenditures. Another important observation is that it is gross income $y_i + r_i$ which matters for the individual budget constraint. According to (2), r_i can partly be influenced by i's contribution behavior g_i, but it also depends on the contribution norm given by the average contributions of the other agents. If this contribution norm is high, a poor agent may not be able to match it so that her gross income is further diminished by sanction $r_i < 0$. As long as $c_i = h(G, \mu) < y_i + r_i$, this has no distributional effects since consumption levels are identical for all agents in interior equilibria. The problem is, if income is too low, no interior equilibria may exist. A possible solution for this problem is to group people according to their income and to apply group-specific contribution norms.[9] We come back to this discussion in the Conclusions. In the further analysis we assume that individuals have identical incomes.

3. Sanctioning Other People´s Behavior

We first consider the case of a non-governmental agency that focuses on sanctions on a strict sub-population $B \subset N$ and invites the rest of the population $A = N \setminus B$ of size $n_A = n - n_B$ (with identical individual incomes y_A and aggregate income $Y_A = n_A y_A$) to contribute to the enforcement fund E. Group $A´s$ contributions to the enforcement fund are E_A, which is employed to induce public good provision by subpopulation B. For a given level of aggregate payments E_A to the enforcement fund, the function $\mu(E_A)$ which indi-

[9] See *Falkinger* [1996] and *Brunner and Falkinger* [1999] for the analysis of equilibria when a partition is applied to the population. These studies focus on efficiency and uniqueness of the resulting equilibria. *Buchholz, Cornes, and Rübbelke* [2011] discuss the risk of the occurrence of corner solutions in such kinds of matching schemes when there is no partition in subgroups, which is due to disparities in income levels. See also *Kirchsteiger and Puppe* [1997].

cates the effectiveness of sanctions will not depend on the size n_A of the sanctioning group A. If there is no rivalry in operationof the enforcement technology, also population size n_B plays no role. For instance, public approval or disapproval of behavior requires collection and distribution of information through mass media whose cost does not much depend on the number of the addressees.

But it may well be possible that sanctions become less effective when the size n_B of the sanctioned group B grows, i.e. μ may be falling in n_B. Members of A do not participate in the provision of G, such that their budget constraint is $c_i + e_A = y_A$, while members of B do not participate in the provision of E, i.e. $E_B = 0$ in eq. (4). For the sake of abbreviation we define $\hat{G}^{(1)}(E_A) \coloneqq \hat{G}(E_A, 0)$ where $\hat{G}(E_A, 0)$ is defined by (4).

The function $\hat{G}^{(1)}(E_A)$ which is twice differentiable defines an indirect contribution 'technology' for the public good G, by assigning to each E_A the equilibrium supply of G induced at stage 2. By taking the derivative of (4), the marginal rate of transformation between E_A and G is

(5) $$\frac{d\hat{G}^{(1)}}{dE_A} = -\frac{n_B h_2(\hat{G}^{(1)}(E_A), \mu(E_A))\mu'(E_A)}{1 + n_B h_1(\hat{G}^{(1)}(E_A), \mu(E_A))} > 0.$$

The inequality in (5) holds since $h_1 > 0$ and $h_2 < 0$. Given some level of E_A, an agent in group A has an incentive to increase unilaterally her contribution to the enforcement fund if and only if

(6) $$-u_1(y_A - e_A, \hat{G}^{(1)}(E_A)) + u_2(y - e_A, \hat{G}^{(1)}(E_A))\frac{d\hat{G}^{(1)}}{dE}(E_A) > 0$$

for $e_A \geq 0$.

Based on inequality (6) it is now possible to characterize the symmetric interior stage-1 equilibrium $(e_i^*)_{i \in A}$ with $e_i^* = e_A^* = \dfrac{E_A^*}{n_A}$.

Proposition 1: Let population N be divided in a group A which only contributes to the enforcement fund E and a disjoint group B which only contributes to the public good G.

Then the contribution e_A^* which each agent from group A makes to the enforcement fund in the subgame-perfect equilibrium is given by

$$mrs_A := \frac{u_1(y_A - e_A^*, \hat{G}^{(1)}(n_A e_A^*))}{u_2(y_A - e_A^*, \hat{G}^{(1)}(n_A e_A^*))} = \frac{d\hat{G}^{(1)}}{dE}(n_A e_A^*) =: mrt \tag{7}$$

where the *mrt* is given by eq. (5).

Comparative statics effects are hard to obtain in the case of a general utility function. As a next step we therefore assume that all agents have the Cobb-Douglas utility function

$$u(c_i, G) = c_i^{\alpha} G^{1-\alpha} . \tag{8}$$

Letting $\rho = \frac{\alpha}{1-\alpha}$, the consumption expansion path $c_i = h(G, \mu)$ is given by

$$h(G, \mu) = \frac{\rho}{\mu} G . \tag{9}$$

The equilibrium condition (7) then becomes

$$\frac{1}{y_A - e_A^*} = \frac{n_B \mu'(n_A e_A^*)}{\mu(n_A e_A^*)(\mu(n_A e_A^*) + n_B \rho)} \tag{10}$$

We can directly infer from (10) how the payments to the enforcement fund change if some exogenous variables change. As an immediate consequence of eq. (5), we then also know the impact of the changes in the stage-2 equilibrium supply of the public good G.

Proposition 2: In the Cobb-Douglas case, individual payment e_A^* to the enforcement fund made by an agent from group A in the subgame-perfect equilibrium increases if either individual income y_A in group A grows, or the preference intensity for the private good ρ or the size n_A of group A fall. Aggregate payment E_A^* to the enforcement fund and public good supply decrease when n_A falls, but increase in all other cases.

Proof: The left-hand side of eq. (10) is an increasing function of e_A. From $\mu'(E_A) > 0$ and $\mu''(E_A) \leq 0$ it follows that the right-hand side of (10) is a decreasing function of $E_A = n_A e_A$.

Given the original equilibrium level of e_A^*, all changes described in the Proposition then imply that the left-hand side in (10) becomes smaller than the right-hand side. To restore equilibrium, the level of individual contributions e_A^* to the enforcement fund must increase. Except for the case when n_A changes, the increase in e_A^* directly leads to an increase in aggregate payment E_A^* to the enforcement fund and - through the concomitant increase of $\mu(E)$ - to a higher public good supply at stage 2 of the game. If n_A falls and thus e_A^* increases by the first part of the Proposition, the left-hand side of (10) grows. If then aggregate payments $E_A^* = n_A e_A^*$ increased, the right-hand side of (10) would become smaller and no equilibrium could be attained. QED

In general, the effectiveness of enforcement will, for any given level of enforcement resources E, be moderated by the number of agents n_B whose norm compliance is to be controlled. To account for different degrees of rivalry, which occur if agents have to be controlled individually, we now use the following specification of the enforcement technology:[10]

$$\mu(E_A) = 1 + n_B^{-\gamma} E_A . \tag{11}$$

Here the effectiveness of E in inducing people to contribute to G is moderated by $n_B^{-\gamma}$. Parameter $\gamma \in [0,1]$ represents the degree of rivalry in the use of E. With $\gamma = 0$, there is no rivalry at all. In the opposite case with $\gamma = 1$, there is full rivalry instead. For the enforcement technology given by (11), condition (10) becomes

$$\frac{1}{y_A - e_A^*} = \frac{n_B^{1-\gamma}}{(1+n_B^{-\gamma}E_A^*)(1+n_B^{-\gamma}E_A^* + n_B\rho)} = \frac{n_B^{1+\gamma}}{(n_B^{\gamma} + E_A^*)(n_B^{\gamma} + E_A^* + \rho n_B^{1+\gamma})} . \tag{12}$$

For this specific situation we have some additional results.

Proposition 3: In the Cobb-Douglas case with an enforcement technology (11) contributions to the enforcement fund are increasing in n_B, if γ is low.

[10] Hence, we set $\beta(E) = 1 - \frac{1}{1+En_B^{-\gamma}}$. This effective sanctioning rate indicates that sanctioning is the stronger, the higher the payments for E and – provided there is rivalry in norm-enforcement – the lower the number of agents in group B.

Proof: Denote the right-hand side of eq. (12) by R. Then $\frac{\partial R}{\partial n_B} \lesseqgtr 0$, if $(1+\gamma)\left(n_B^\gamma + E_A^*\right)\left(n_B^\gamma + \rho n_B^{1+\gamma} + E_A^*\right) \lesseqgtr n_B\left\{\gamma n_B^{\gamma-1}\left(n_B^\gamma + \rho n_B^{1+\gamma} + E_A^*\right) + \left(n_B^\gamma + E_A^*\right)\left[\gamma n_B^{\gamma-1} + \rho(1+\gamma)n_B^\gamma\right]\right\}$.

The inequality is equivalent to the condition

$$1+\gamma \lesseqgtr \frac{\gamma n_B^\gamma}{n_B^\gamma + E_A^*} + \frac{\gamma n_B^\gamma + \rho(1+\gamma)n_B^{1+\gamma}}{n_B^\gamma + \rho n_B^{1+\gamma} + E_A^*}.$$

For γ approaching zero, the left-hand side is equal to one, while the right-hand side becomes $\frac{\rho n_B}{1+\rho n_B + E_A^*} < 1$. Thus, $\frac{\partial R}{\partial n_B} > 0$ and $\frac{\partial E_A^*}{\partial n_B} > 0$. QED

4. Norm Enforcement with Universal Coverage: Sanctioning Everybody

We consider now the situation in which group B, whose members contribute to the public good G, comprises the whole economy, i.e. $B = N$, and thus $E_B = E_A$. Group A, whose members also contribute to the enforcement, may also be equal to N or, alternatively, may be a subgroup of N. All agents in the economy are assumed to have the same income level y. For the sake of abbreviation define $\hat{G}^{(2)}(E) := \hat{G}(E,E)$, where $\hat{G}(E,E)$ is given by (4) for $E := E_A = E_B$, and $\hat{c}^{(2)}(E) := h(\hat{G}^{(2)}(E), \mu(E))$. The equilibrium at stage 2 therefore is completely the same irrespective of whether A coincides with the whole population N or is only a subgroup. Moreover, as a direct implication of $A \subseteq B = N$ and optimality condition (3) each agent in group A has the same private consumption level in an equilibrium at stage 2 as each agent outside A. This means that any agent´s contribution to the enforcement fund E is completely offset by a reduction of her contribution to the public good G.

Looking at the first stage of the game, the condition characterizing E^* in a subgame-perfect equilibrium is now

(13) $$u_1(\hat{c}^{(2)}(E^*), \hat{G}^{(2)}(E^*))\frac{d\hat{c}^{(2)}}{dE}(E^*) + u_2(\hat{c}^{(2)}(E^*), \hat{G}^{(2)}(E^*))\frac{d\hat{G}^{(2)}}{dE}(E^*) = 0$$

or equivalently, observing that $\mu(E) = \frac{u_1(\hat{c}^{(2)}(E), \hat{G}^{(2)}(E))}{u_2(\hat{c}^{(2)}(E), \hat{G}^{(2)}(E))}$ holds in the equilibrium at stage 2,

(14) $$\mu(E^*) = -\frac{d\hat{G}^{(2)}/dE}{d\hat{c}^{(2)}/dE}(E^*).$$

Since the size of group A does not matter for this condition, we have the following result:

Proposition 4: If $B=N$, then the subgame-perfect equilibrium, as characterized by (4) and (14), does not depend on the size n_A of subgroup A. Moreover, all agents have the same private consumption level in equilibrium, irrespective of whether they are in group A or not.

For the further analysis we calculate from (3) and (4), now omitting all variables, $\frac{\partial \hat{G}}{\partial E} = -\frac{1+nh_2\mu'}{1+nh_1}$ and $\frac{\partial \hat{c}}{\partial E} = -\frac{h_1 - h_2\mu'}{1+nh_1}$. Then, equilibrium condition (14) becomes

(15) $$\mu(E^*) = -\frac{1+nh_2\mu'}{h_1 - h_2\mu'}.$$

Since $h_1 > 0$ and $h_2 < 0$, the denominator in (15) is always positive. Thus, as $\mu \geq 1$, $nh_2\mu' < -1$ must hold in a subgame-perfect equilibrium.

Based on condition (15) one can show that in a subgame-perfect equilibrium the public good G is underprovided in a certain sense.

Proposition 5: Public good supply $\hat{G}(E^*)$ in the subgame perfect equilibrium is lower than in the symmetric Pareto optimal solution (in which all agents have the same level of private consumption) of an economy with endowment $Y - E^*$.

Proof: In a symmetric Pareto optimal solution all agents have the same level of private consumption and the Samuelson condition $nu_2/u_1 = 1$ implies $u_1/u_2 = n$. In contrast, it follows from (15) and $h_1 > 0$, $h_2 < 0$, $\mu' > 0$ that in the subgame-perfect equilibrium

(16) $$\mu(E^*) = \frac{-nh_2\mu'-1}{-h_2\mu'+h_1} < \frac{n(-h_2\mu')}{-h_2\mu'} = n.$$

Thus, $u_1/u_2 = \mu(E^*) < n$. This implies that $\hat{c}(E^*)$ is higher and $\hat{G}(E^*)$ is lower than the respective values in a symmetric Pareto optimal solution for aggregate endowment $Y - E^*$.

QED

For the subsequent comparative statics exercises we again assume Cobb-Douglas preferences. Observing from (9) that $h_1 = \frac{\rho}{\mu}$ and $h_2 = -\frac{\rho}{\mu^2} G$, condition (15), which characterizes aggregate contributions E^* to the enforcement fund in the subgame perfect equilibrium, becomes

(17)
$$\mu(E^*) = -\frac{1 - n\frac{\rho}{\mu(E^*)^2}\hat{G}(E^*)\mu'(E^*)}{\frac{\rho}{\mu(E^*)} + \frac{\rho}{\mu(E^*)^2}\hat{G}(E^*)\mu'(E^*)} = -\frac{\mu(E^*)^2 - n\rho\hat{G}(E^*)\mu'(E^*)}{\rho(\mu(E^*) + \hat{G}(E^*)\mu'(E^*))} \,.$$

With $E_B = E_A = E$ and (9), condition (4) reduces to

(18)
$$\hat{G}(E) + n\frac{\rho}{\mu(E)}\hat{G}(E) = Y - E$$

which gives public good supply in the equilibrium at stage 2

(19)
$$\hat{G}(E) = \frac{\mu(E)(Y-E)}{\mu(E)+n\rho} \;.$$

Using (19) in (17) and observing that $\alpha = \frac{\rho}{1+\rho}$, we obtain

(20)
$$\frac{1}{Y-E^*} = \alpha\frac{\mu'(E^*)(n-\mu(E^*))}{\mu(E^*)(\mu(E^*)+n\rho)} = \frac{\mu'(E^*)}{\mu(E^*)}\left(\frac{n\rho}{\mu(E^*)+n\rho} - \alpha\right).$$

Concerning the enforcement technology we now make the assumption that

(21)
$$\frac{\mu'(E)}{\mu(E)} \text{ is non-increasing in } E.$$

Assumption (21) is clearly fulfilled when $\mu(E)$ is linear as in specification (11). We get the following comparative statics results.

Proposition 6: Under Cobb-Douglas preferences and assumption (21), total equilibrium contributions E^* to the enforcement fund increase if

(i) other things equal, income Y increases, or

(ii) other things equal, the size of the economy n increases and if the effectiveness of sanctions μ does not depend of n.

Proof: With (21), the right-hand side of condition (20) decreases in E^* while the left-hand side increases in E^*. (i) holds as the left-hand side of (20) falls when Y grows. (ii) is obtained because adding an agent to the economy increases the right-hand side of (20) whereas its left-hand side is constant. QED

In order to see how the subgame-perfect equilibrium is affected if the effectiveness of sanctions μ depends on the size of the economy, we again assume the specific enforcement technology described by (11). Since now $n_B = n$, concerning the effectiveness of μ we have to look at $e^* = E^*/n$, the size of the enforcement fund per member of the economy. With (11) we can rewrite equilibrium condition (20) in the form

(22) $$\frac{1}{y-e^*} = \frac{1}{(n^{\gamma-1}+e^*)}\left(\frac{\rho}{n^{-1}+n^{-\gamma}e^*+\rho} - \alpha\right).$$

From this we get the following results.

Proposition 7: If agents have Cobb-Douglas preferences and the enforcement technology is given by (11), then the equilibrium level of the enforcement fund per head, e^*, is

(i) positive for n larger than some threshold $\bar{n}$.

(ii) increasing in the size of the economy n.

(iii) never larger than $\frac{y}{2}$.

Proof: The left-hand side of condition (22) is increasing in e^* starting at value $\frac{1}{y}$ if $e^* = 0$ and converging to infinity if e^* approaches y. The right-hand side of (22) has for any $n \geq 1$ a finite value and takes for $e^* = 0$ the value $n^{1-\gamma}\left(\frac{\rho}{n^{-1}+\rho} - \alpha\right)$ which clearly exceeds $\frac{1}{y}$ if n is large enough. It follows from the intermediate value theorem that there exists some $\underline{n}$ such that both sides of (22) are equated at some $\underline{e}^* > 0$. Moreover, since the right-hand side of (22) is decreasing in e^* and increasing in n, e^* is increasing in n and $e^* > \underline{e}^*$ for $n > \underline{n}$. This proves (i) and (ii). Part (iii) is shown by the following argument. If n goes to infinity, condition (22) converges to $\frac{1}{y-\bar{e}^*} = \frac{1}{\bar{e}^*}(1-\alpha)$ which gives $\bar{e}^* = \frac{1-\alpha}{2-\alpha}y < \frac{1}{2}y$ as an upper bound.

QED

These results are in sharp contrast to those obtained in the standard situation of voluntary provision of a public good (see *Andreoni* [1988]). Free-riding in supplying the second-order public good 'enforcement' is less a problem in large societies than in small groups. Per-capita contributions to the enforcement fund do not only rise with average income but also with the size of the population towards which the incentive scheme of the enforcement agency is targeted. This means that also in large societies strictly positive contributions to enforcement result as a non-cooperative outcome, and enforcement funds can be raised successfully by a non-governmental agency. The reason is that individuals anticipate that by contributing to enforcement with universal coverage, they are exerting pressure on themselves and on all others to contribute to the first-order public good at the second stage of the game. In small groups, specific individual motives like altruism or some willingness to execute costly punishment may help to improve public good provision. In large anonymous societies, such reliance on altruistic behavior seems less convincing – nor is it necessary, as the analysis presented here shows.

It is worth noting that Proposition 7 holds for any $\gamma \in [0,1]$. Hence, economies of scale in the enforcement technology are not essential for the result that also in large economies individuals make voluntary contributions to enforcement. Even full rivalry, i.e. $\gamma = 1$, does not destroy the incentives to invest in an enforcement technology.

Raising funds for non-governmental approval or disapproval of behavior therefore works. But does it help to increase public good provision at the second stage of the game? There are two opposing effects at work: On the one hand, the agents´ incentives to contribute to the public good G are improved by means of the enforcement mechanism and in a larger economy the incentives to contribute to enforcement increase. On the other hand, sanctioning is costly and thus the income left for the provision of the public good is reduced when individual contributions to the enforcement fund increase. Moreover, in a larger economy higher amounts of enforcement funds are needed to overcome free-riding behavior in the contribution game to G. As long as there is non-rivalry in enforcement the first effect will dominate and individual contributions to the public good G are strictly bounded away from zero even if population size grows towards infinity. In contrast, with full rivalry in enforcement, individual public good contributions eventually approach zero. These results are shown in the following Proposition.

Proposition 8: Assume that agents have Cobb-Douglas preferences and the enforcement technology is given by (11).

(i) If $\gamma = 0$, then there is some $\underline{g} > 0$ such that $\hat{g}(E^*) = \frac{\hat{G}(E^*)}{n} \geq \underline{g}$ for all n sufficiently large.

(ii) If $\gamma = 1$, then $\lim_{n\to\infty} \hat{g}(E^*) = 0$.

Proof: (i) If $\gamma = 0$ it follows from (19) that for all $n \geq 2$

(23) $$\hat{g}(E^*) = \frac{(1+ne^*)(y-e^*)}{1+ne^*+n\rho} = \frac{y-e^*}{1+\frac{\rho}{\frac{1}{n}+e^*}}.$$

From Proposition 7, we know that $e^* > \underline{e}^*$ for all $n \geq \underline{n}$, and that e^* is bounded above by $\frac{y}{2}$. Moreover, $\hat{g}$ is decreasing in n. Therefore, we get for all $n \geq \underline{n}$ that

(24) $$\hat{g}(E^*) \geq \underline{g} := \frac{y}{2(1+\frac{\rho}{\underline{e}^*})} > 0.$$

(ii) If $\gamma = 1$ and as clearly $e^* < y$, we have for all n

(25) $$\hat{g}(E^*) = \frac{(1+e^*)(y-e^*)}{1+e^*+n\rho} < \frac{(1+y)y}{1+n\rho}.$$

The assertion holds since the right-hand side of (25) converges to zero when n goes to infinity. QED

The central conclusion which can be drawn from part (i) of Proposition 8 is that even in large societies the private provision of the public good G does not break down when there is non-rival enforcement. Without enforcement, things would be quite different as then individual contributions would - in the voluntary provision equilibrium - necessarily go to zero if the size of the economy converges towards infinity. This follows from equation (23) as a special case when e^* is set to zero. Thus, in a two-stage game of private public good provision, voluntary contributions to norm enforcement at the first stage can support provision of the public good G at the second stage also in very large societies in which agents virtually would make no contributions to G without enforcement.

With rival enforcement as considered in part (ii) of Proposition 8, the enforcement activities still help to increase individual contributions to the public good beyond the level that would be achieved without enforcement which is $\frac{y}{1+n\rho}$.[11] Yet, if the size of the economy increases, individual contributions to the public good eventually vanish. The reason is, that under conditions of rivalry of enforcement, the resources put into the enforcement fund do not have enough power for overcoming the free-riding incentives in the supply of the public good at stage 2 when n is large.

5. Conclusions

Enforcing a norm involves a twofold public good problem. First, complying with a norm means that agents contribute a certain amount to a public good G. For instance, behaving in accordance with environmental standards improves environmental quality. This is why norm compliance is desirable in the first place. Second, enforcing the norm is also a public good, subject to the following free-rider incentive: Let others pay the funds required for financing enforcement activities. To cope with these two aspects, the determinants and the effects of non-governmental norm enforcement were analyzed in a two-stage non-cooperative contribution game.

We first characterized the size of funds raised in equilibrium when a non-governmental agency is financed by a subgroup of agents whereas its activities are targeted at the rest of the population. We then considered the alternative case under which the enforcement agency monitors the whole population to contribute to the public good G, while the group that finances the enforcement agency may coincide with the total population or consist of a subgroup of the population monitored by the agency. In both cases we showed that norm enforcement can be sustained as a non-cooperative equilibrium even in large populations with standard non-altruistic preferences.

These results explain why fund-raising for non-governmental norm enforcement is successful. Its effectiveness, however, much depends on the properties of the enforcement technology. If enforcement activities are non-rival – that is, if surveillance and public approval/disapproval of contribution behavior to the public good G involve mainly fixed costs – then the funds raised in non-cooperative equilibrium suffice to induce substantial supply of the public good at the second stage of the game even in a very large society.

[11] Using $e^* < \frac{y}{2}$, it follows from a short calculation that $\hat{g}(E^*) = \frac{(1+e^*)(y-e^*)}{1+e^*+n\rho} > \frac{y}{1+n\rho}$ if n is large enough.

If, in contrast, enforcement activities are subject to rivalry – i.e. resources employed for inspection of some agent cannot be used for inspecting another agent – non-governmental norm enforcement still has a positive effect on public good provision. Yet, it is smaller than in the non-rivalry case and it vanishes as population size approaches infinity.

This paper was confined to the positive analysis of non-governmental norm enforcement. An important issue left open in this paper is the question of distributive equity. For instance, one might argue that it is unfair that social pressure and social approval by a non-governmental enforcement agency is for all people equally based on the deviation of their individual contribution from the average contribution of the whole population, irrespective of the income of the individual and thus its ability to pay.[12] The approach taken in this paper was positive in the sense that only the effectiveness of non-governmental enforcement was analyzed and no advice was given with regard to the appropriate design of a non-governmental enforcement agency when the distributional fairness of behavioral norms is taken into consideration. For instance, the enforcement agency could apply a partitioning of people, as considered in *Falkinger* [1996] or in *Brunner and Falkinger* [1999], and group people according to their income. In this case, an individual´s contribution to the public good would be compared with the average of its income group rather than with the average of the whole population. Another possibility could be that the enforcement agency compares the shares of the contributions to the public good in the individual budgets rather than the levels of contributions.

This leaves two kinds of questions for future research. The one is: Given a certain welfare function, what is an optimal design for non-governmental organizations? As a result, such a research strategy could lead to recommendations about how to regulate non-governmental activities. The other one is: Suppose that different non-governmental organizations apply different sanctioning technologies. When some of them more account for distributional equity than others, which one can be expected to attract more funds? Ultimately, such a research program could lead to predictions about the characteristics of successful non-governmental organizations compared to less successful ones.

[12] There is some sociological evidence (see, e.g., *Wilkinson and Pickett* [2009, 2010]) that the effectiveness of social norms is stronger in societies with low income inequality and homogenous social groups.

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